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UK CL (Edition R) G1N NAAJI NABA NADE
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(54) Abstract Title
**Viscosity measurement utilising piezo-electric bars**

(57) Piezo bar or bars (3) are used to measure the viscosity of the fluids in which they are immersed (11) for example the Piezo bar (3) fixed within a housing (2) has a single input voltage pulse applied.

The instant the pulse ends any output voltage induced by the diminishing oscillations of the Piezo bar (3) is used in conjunction with the temperature sensed by sensor (9) to calculate the viscosity of fluid.

In a further example opposing Piezo bars (3a and 3b) on the same plane with a set gap (5) between are internally fixed within the housing (2). An alternating current is applied to the driver Piezo bar (3a) the driven Piezo bar (3b) assimilate this movement according to the amount of shear effect of the fluid (11) within the set gap (5). The Piezo bars (3a and 3b) can also remotely operate discs (18 and 19) or tubes (20 and 21) where the only a small set gap (5) exists between the discs (5a and 5b) or tubes yet the shear effect is over a greater area.

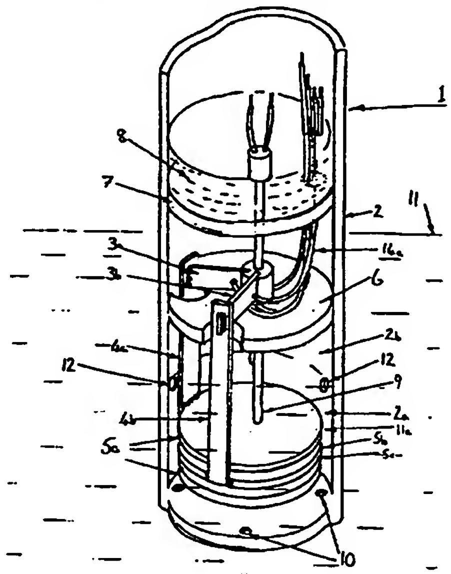


Fig 1

The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

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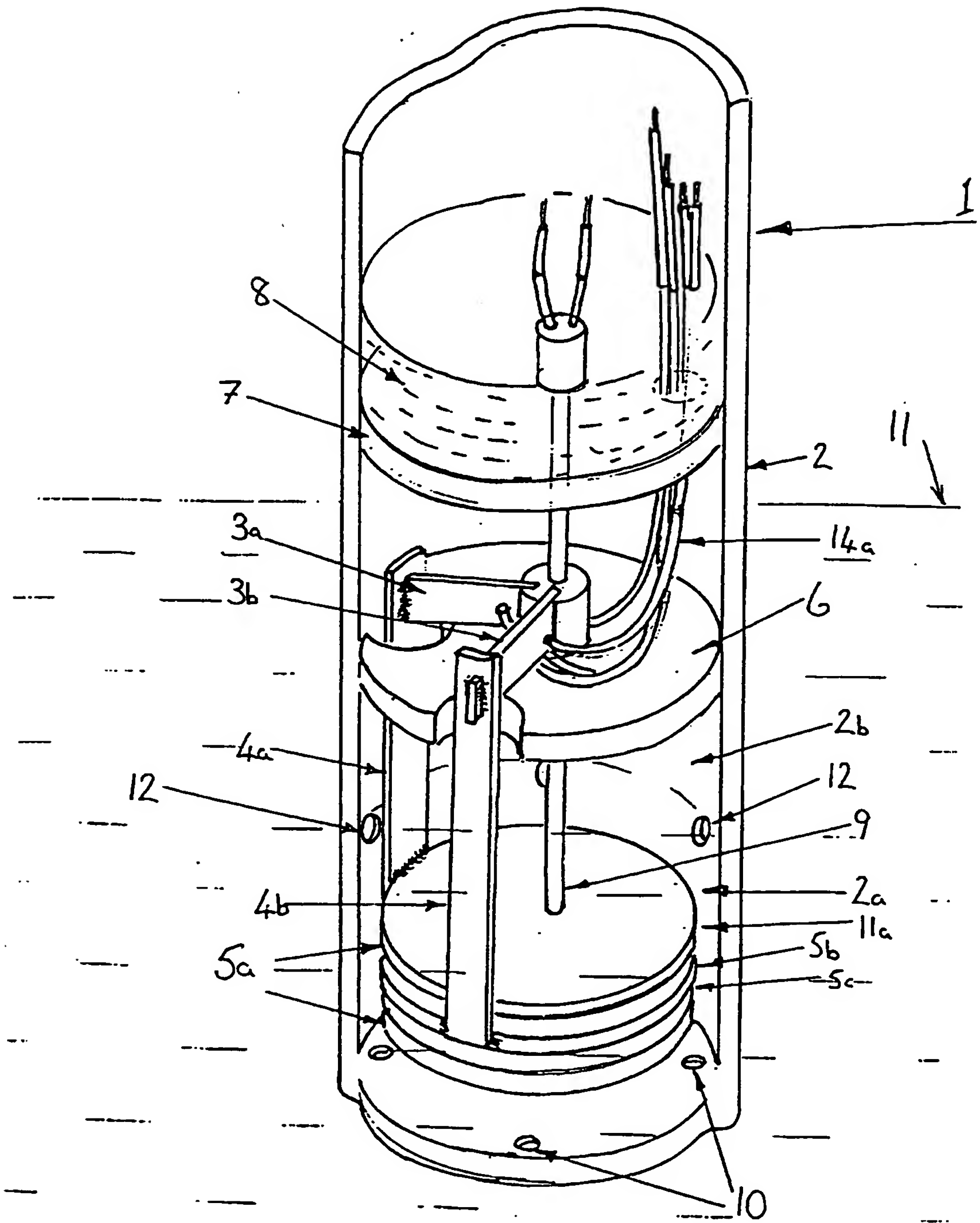


Fig 1

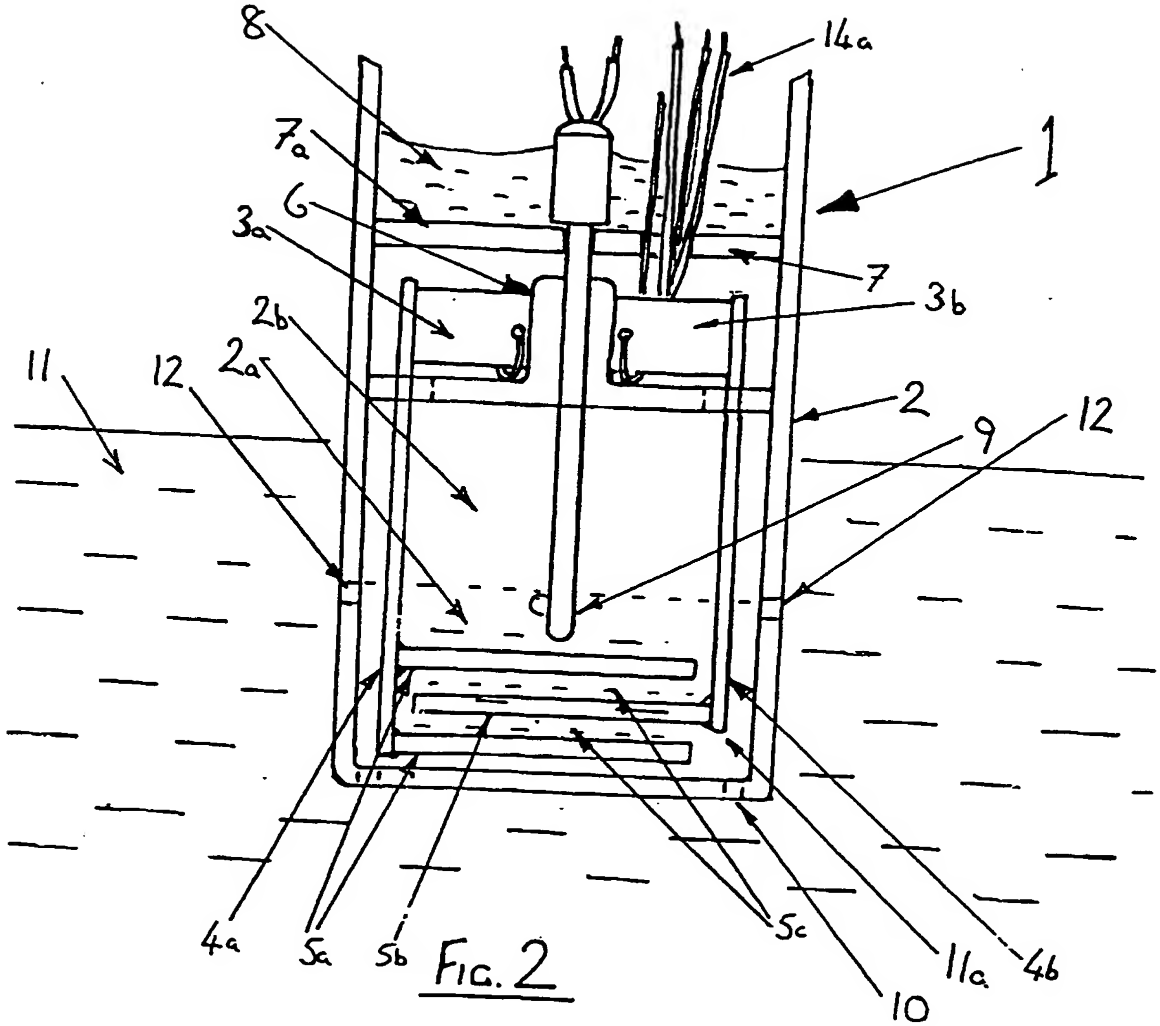


FIG. 2

Fig 3

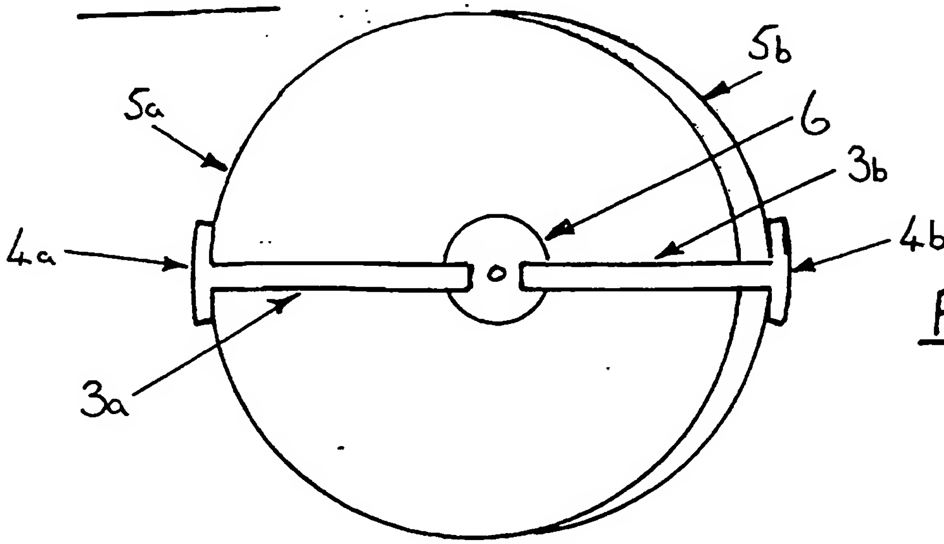


Fig 3a

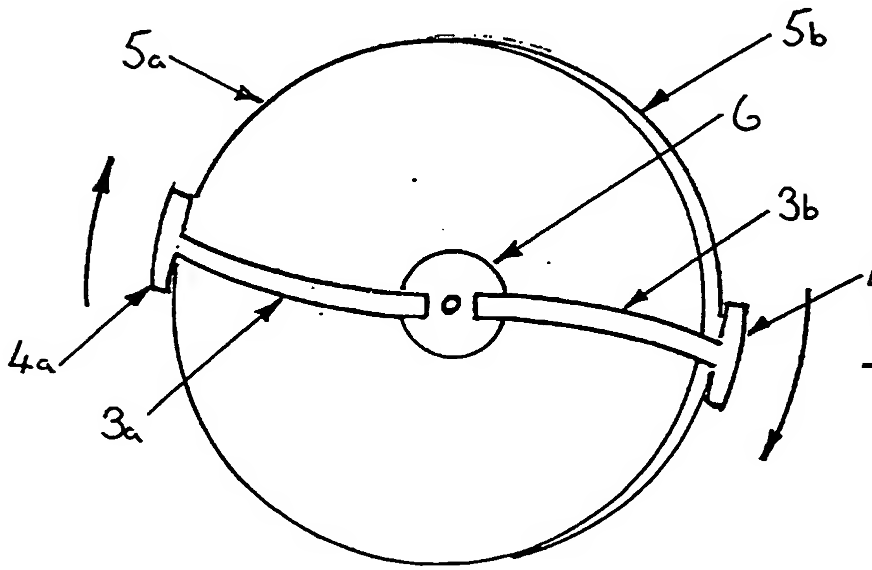


Fig 3b

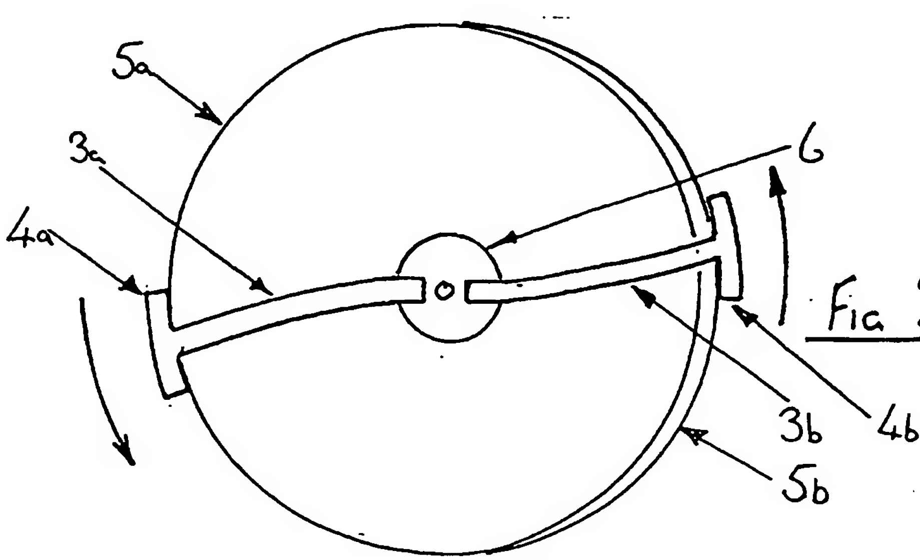


Fig 3c

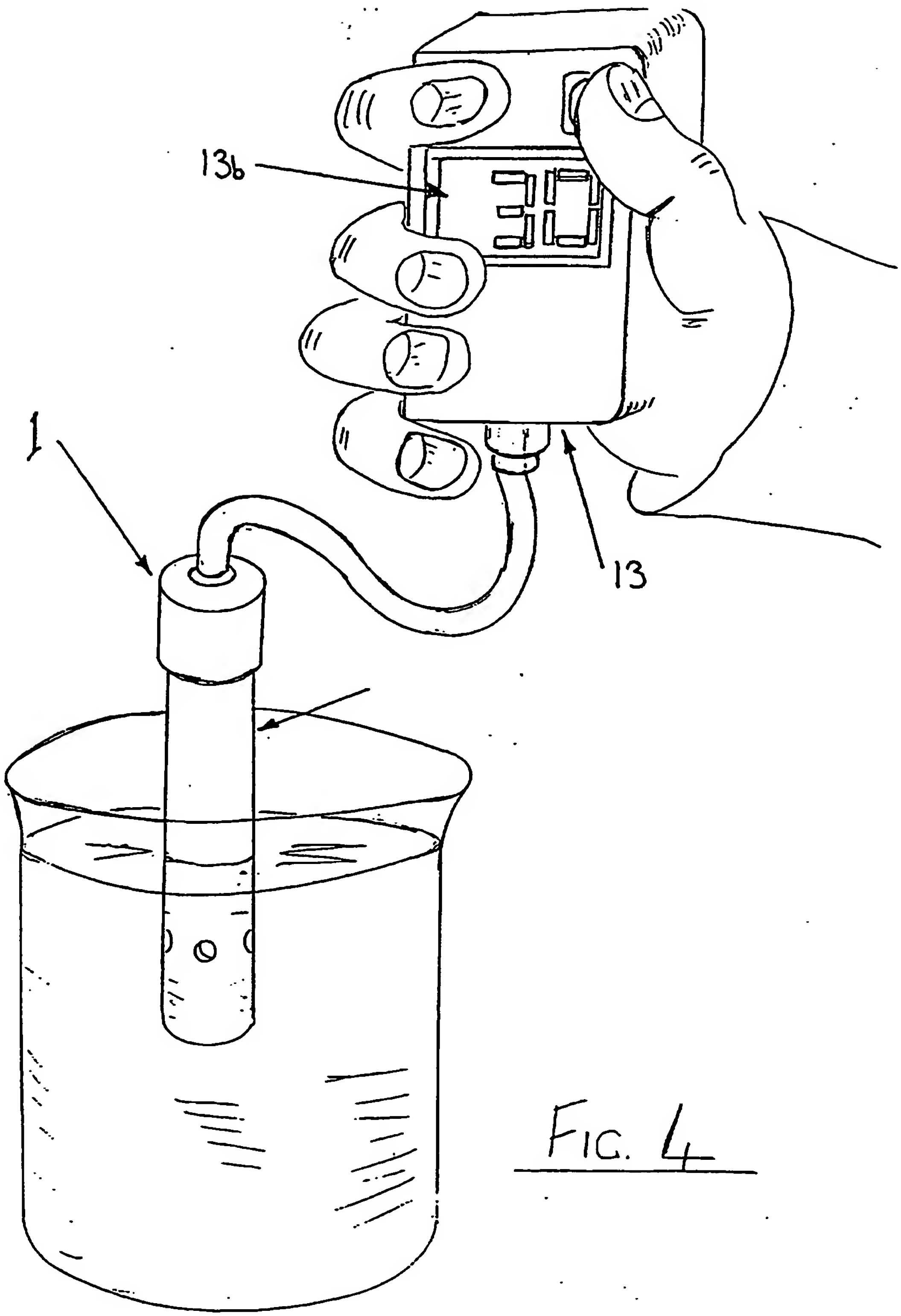


FIG. 4

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# Viscotest

This invention relates to a Viscosity Tester.

Viscosity testers are well known which consist of various methods of measuring different fluids, mainly oils, to determine the condition of their viscosities. Viscosity testers are however usually laboratory type instruments, it is the purpose of this invention to provide a preferably portable viscosity tester giving an accurate test result in a timeous manner without withdrawal of the fluid to be tested.

According to the present invention there is provided a viscosity tester wherein a plurality of preferably circular discs are placed such that when the driver disc or discs are rotated the viscosity of the test fluid in the small gap between the driver disc and the driven disc or discs causes the driver discs also to rotate. The amount of assimilation by the driven discs varies according to the viscosity of the test fluid between the driver and the driven discs.

The driver disc is preferably rotated backwards and forwards in an arc in a cyclical manner. The operator for the driver discs is preferably a Piezo bar fixed at one end to a ridged part of the probe such that when a suitable alternating voltage is applied to the operating Piezo bar it causes the driver discs to oscillate backwards and forwards in a cyclical manner, via a connecting arm, allowing the operating Piezo bar to be remote from its driver discs which are immersed in the test fluid. The driven disc and its operated Piezo bar and connecting arm are mounted in a similar manner.

The operating and operated Piezo bars, their connecting arms, driver and driven discs are preferably housed in a cylindrical housing with aperture means on the base and further side aperture means on the side of the probe at a point above the driver and driven discs, whereby when the probe is immersed, generally upright, in the fluid to be tested to a level above the side aperture means the driver and driven discs are fully immersed in the fluid to be tested. At a point above the operating and operated Piezo bars the probe is sealed by a plug enabling air to be trapped above the side aperture means, the operating and operated Piezo bars are situated within this gap above the side aperture means the second housing. The driver and driven discs are immersed in the test fluid below the side aperture means the first housing. The test fluid can timeously flow into the probe through the base aperture means, air being displaced through the side aperture means allowing fluid to rise within the probe to approximately the level of the top of the side aperture means.

An electronic temperature monitoring means is situated with its measuring tip immersed in the test fluid in the first housing. The voltage created as the driven disc oscillates bending the operated Piezo bar and the voltage sensed by the electronic measuring means are used by a known electronic monitoring and display means to calculate and display a value representing the viscosity of the fluid tested.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1
Shows, in cut-away section, the probe housing containing the operated and operating Piezo bars, their connecting arms, the driver and driven discs, the electronic measuring means and their central fixed retainer.

Figure 2
Illustrates, in section, the probe cylindrical housing immersed in the fluid to be tested, the air trapped within the second housing above the side aperture means defining the fluid level within the first probe housing. The driver and driven discs are immersed in the fluid to be tested.

Figure 3
Shows, in schematic form, above the operating and operated Piezo bars the discs with their connecting arms. Only part of the stationary retainer is shown in the centre retaining the Piezo bars.

Figure 3a
Shows the operating Piezo bar at rest with no voltage applied.

Figure 3b
Illustrates the operating Piezo bar with a suitable voltage applied, the driver disc turning in the fluid to be tested via its connecting arm. The driven disc also turning in the same direction to an amount relative to the viscosity of the fluid between the driver and driven discs. The operated Piezo bar deflecting in proportion to the force applied to its connecting arm.

Figure 3c
**Shows the operating Piezo bar with the suitable voltage reversed in polarity, such as to cause the operating Piezo bar to deflect in the opposite direction. When a suitable alternating voltage is applied to the operating Piezo bar it will oscillate in a cyclical manner causing the operated Piezo bar to assimilate the movement according to the degree of shear effect caused by the fluids viscosity between driver and driven discs.**

Figure 4
**Shows the probe cylindrical housing connected by an umbilical cable to a suitable electronic monitoring display means.**

**Referring to the drawing the viscosity tester [1] comprises of a preferably cylindrical housing [2] wherein the preferably Piezo operating and operated bars [3a] & [3b], their connecting arms [4a] & [4b], driver and driven discs[5a] &[5b] are fitted to a central fixed retainer [6] above which is fitted a sealing ring [7] with sealing compound [8] above its upper surface [7a] forming a plug. An electronic temperature measuring means [9] is fixed through the central fixed retainer [6].**
**Base aperture means [10] allows the fluid to be tested [11a] to flow too and fro from the confines of the cylindrical probe housing [2]. Air from the first housing [2a] is dispelled from side aperture means [12] creating a fluid zone for the fluid to be tested [11a] within the first housing [2a].**

Air is trapped above side aperture means [12] by the sealing of the inner probe housing [2] above the Piezo bars [3a] & [3b]by the sealing ring [7] and sealing compound [8] creating a trapped air zone second housing [2b] in which the Piezo bars [3a] & [3b] can freely operate. A suitable known electronic control display means [13] is connected to the cylindrical housing [2] , preferably by a known umbilical cable [14], wires [14a] within the cable [14] connect the operating and operated Piezo bars [3a] & [3b] to the electronic control and display means [13a] & [13b].

When the cylindrical probe housing [2] is immersed into the fluid to be tested [11] passed the side aperture means [12] the driver and driven discs [5a] & [5b] are immersed in the fluid to be tested [11a] a small and preferably set and uniform gap [5c] exists between driver and driven discs [5a] & [5b], this gap [5c] fills with the fluid to be tested [11a]. When the operating, preferably, Piezo bar [3a] has a suitable alternating voltage applied it bends in an arc around the central fixed retainer [6] in a cyclical manner, the driver disc [5a] is moved in the same arc by its operating arm [4a] the opposing surfaces of the driver and driven discs [5a] & [5b] are preferably textured in a set repeatable manner. The viscosity of the fluid to be tested [11a] in the small controlled gap [5c] between the driver and the driven discs [5a] & [5b] creates drag between the driver and driven discs [5a] & [5b]. The higher the viscosity of the fluid to be tested [11a] the higher the drag between the discs [5a]& [5b] the higher the voltage induced in the driven Piezo bar [3b].

**This induced voltage in conjunction with the voltage from the temperature measuring means [ 9] are fed into the known electronic control means [13a] where they are electronically calculated to the corresponding fluid viscosity reading which can be displayed on the electronic display [13b].**

## CLAIMS

1) A Viscosity Tester (1) wherein a Piezo bar or bars (3) are used to measure the viscosity of the test fluid (11) the viscosity tester (1) is immersed in.
In one example a Piezo bar (3) fixed at one end using a known fixing material (15) to the inside of the housing (2) has a single input voltage pulse (16c) applied. The instant the pulse(16c) ends any output voltage (17c) induced by the diminishing oscillations of the Piezo bar(3) is used in conjunction with the temperature sensed by the known electronic temperature sensor (9)to calculate the viscosity of the test fluid (11).

2) A Viscosity Tester (1) wherein dual Piezo bars (3a & 3b) are fitted on the same plane within a frame or housing (2).
The outer edges of the Piezo bars (3a & 3b) are firmly fixed within the housing (2). A small set gap (5) exists between the Piezo bars (3a & 3b) at their inner edges (3c & 3d). When a suitable alternating voltage (16b) is applied to the driver Piezo bar (3a) the Piezo bar will oscillate at the frequency of the applied alternating voltage (16b) applied when the Viscosity Tester (1) is immersed in the fluid to be tested

**(11) the driver Piezo bar (3a) will oscillate the greatest at its inner edge (3c). The resultant shear effect on the fluid(11) in the set gap (5)between the opposing Piezo bars (3a & 3b) causes the driven Piezo bar (3b) to oscillate at the same frequency as the driver Piezo bar (3a), the degree of oscillation of the driven Piezo bar (3b) varying according to the viscosity of the test fluid (11) between the opposing Piezo bars (3a & 3b).**

**The induced voltage (17b) caused by the movement of the driven Piezo bar (3b) is used in conjunction with the temperature sensed by the known temperature sensing means (9) to calculate the viscosity of the test fluid (11).**

**3) A Viscosity Tester (1) wherein the inner edge of the dual Piezo bars (3a &3b) is fixed to a ridged part (6) of the frame or housing (2) and the outer edge of the Piezo bars (3a & 3b) are fixed to operating arms (4a & 4b) which extend downwards where they are fixed to preferably circular drive and driven discs (18 & 19) with a set gap (5) between them. The driver disc (18) is preferably rotated backwards and forwards in an arc in a cyclical manner. The driver Piezo bar (3a) is fixed at one end to the ridged part (6) of the housing (2) such that when a suitable alternating voltage (16a) is applied to the driver Piezo bar (3a) it causes the driver disc or discs (18) to oscillate backwards and forwards in a**

**cyclical manner, via a connecting arm (4a) allowing the driver Piezo bar (3a) to be remote from its driver disc or discs (18) which are immersed in the test fluid (11). The driven disc or discs (19) and its operated Piezo bar (3b) and connecting arm(4b) are mounted in a similar manner.**

**The shear effect of the test fluid (11) within the set gap (5) as the driver disc (18) oscillates acts on the driven disc (19) causing the driver Piezo bar (3b), via its connecting arm (4), to oscillate generating an output voltage (17a) which can be used in conjunction with the temperature of the test fluid (11) sensed by the known temperature sensor (9) to calculate the viscosity of the test fluid (11)**

**The driver and driven Piezo bars (3a & 3b), their connecting arms (4a & 4b), driver and driven discs (18 & 19)) are preferably housed in a cylindrical housing (2)with aperture means (10) on the base and further side aperture means (12) on the side of the housing (2)at a point above the driver (18) and driven discs (19), whereby when the housing (2) is immersed, generally upright, in the fluid to be tested (11)to a level above the side aperture means (12) the driver (18) and driven discs (19)are fully immersed in the fluid to .be tested (11)**

**4) A Viscosity Tester (1) as in Claim 3 wherein the driver (18)**

and driven discs (19) are replaced with tubular cylinders (20 & 21). When a suitable alternating voltage (16a) is applied to the driver Piezo bar (3a) it causes the driver tubular cylinder (20) to oscillate around the driven tubular cylinder (21) in a cyclical manner via connecting arms (4a & 4b). A suitable sized set gap (5) between the tubular cylinders (20 & 21) allows the test fluid (11) upon immersion in the fluid to fill the set gap (5).
The shear effect of the test fluid (11) within the set gap (5) as the driver tubular cylinder (20) oscillates acts on the driven tubular cylinder (21) causing the driven Piezo bar (3b) via its connecting arm (4b) to oscillate generating an output voltage (17a) which can be used in conjunction with the temperature of the test fluid (11) sensed by the known temperature sensor (9) to calculate the viscosity of the test fluid (11).

5) A Viscosity Tester (1)as in Claims 3 & 4 wherein the driver tubular cylinder (20) is within the confines of the driven tubular cylinder (21).

6) A Viscosity Tester (1) as in Claims 3, 4 & 5 wherein the surfaces of the driver or driven discs (18 & 19) or alternatively the driver or driven tubular cylinders (20 & 21) that form the set gap (5) are textured to provide a greater

**shear effect within the test fluid (11) during operation.**

**7) A Viscosity Tester (1) as in claims 3,4 5 & 6 wherein the housing (2) is sealed by a plug (7) and, if required, a sealer (8) at a point above the driver (3a) and driven (3b) Piezo bars enabling air to be trapped above the side aperture means (12) , the driver and driven Piezo bars (3a & 3b) are situated within this air zone (2b) above the side aperture means (12) the second housing (2b). The driver and driven discs (18 & 19) or tubular cylinders (20 & 21) are immersed during a test in the test fluid (11) below the side aperture (12) means the first housing (2a). The test fluid (11) can timeously flow into the housing (2) through the base aperture means (10), air being displaced through the side aperture means (12) allowing the test fluid (11) to rise within the housing (2) to approximately the level of the top of the side aperture means (12).**

**8) A Viscosity Tester (1) as in previous claims wherein an electronic temperature monitoring means (9) is situated with its measuring tip immersed in the test fluid (11) within the housing (2 & 2a). The output voltage (17a) created as the driven disc (19) or driven tubular cylinder(21) oscillates bending the driven Piezo bar ( 3b) immersed in the test fluid (11) and the voltage sensed by the known**

**electronic temperature monitoring means (9) are used by a known electronic monitoring and display means (13) to calculate and display a value representing the viscosity of the fluid being tested (11).**

**Application No:** GB 9819834.4 **Examiner:** Eamonn Quirk
**Claims searched:** 1 & 8 **Date of search:** 30 January 2000

## Patents Act 1977
## Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): G1N(NAAJI, NABA, NADE )

Int Cl (Ed.7): G01N (11/16)

Other: WPI, JAPIO, EPODOC

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|---|---|---|
| Y | US 5 710 374 (University of Virginia) Whole document | 1,8 |
| Y | US 4 704 898 (Ernst Thorne) Figure 1 and abstract | 1,8 |
| X | Patent Abstracts of Japan 2 October 1984 & JP 59 099 332 A (Nippon Jidosha Buhin Sogo Kenkyusho KK) published 8 June 1984. | 1,8 |
| X | WPI Acc. No. 86-237939 & SU 1 210 077 A (Tashkent Poly) published 7 February 1986. | 1,8 |



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